Existence in parapatry of two species of *Ophisops* in Algeria (Aures): zoogeographical implications

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Abstract. Two species of *Ophisops*, *O. occidentalis* and *O. elegans* (Lacertidae), occur in the Aures massif, Algeria, with a parapatric distribution. In relation to current ecological and bioclimatical factors, this situation is explained by an interspecific exclusion favouring *O. occidentalis*. Quaternary climatic modifications may have been responsible for wide variations in the distribution areas of *Ophisops* in Northern Africa, and account for their current geographical separation.

Introduction

The Aures massif in northern Algeria is geomorphologically distinct within the Saharian Atlas range. It is separated to the West from the Mounts Belezma by the Oued el Hai valley and to the East from the Nementcha mountain by the Oued el Arab valley (fig. 1). Several large north-east to south-west folds of the sedimentary layers determine the orientation of the two main inner valleys of the oueds Abdi and el Abiod. The altitude of the watershed ranges from 1650 m at the Medina pass to 2328 m at the top of the Djebel Chelia. The mean altitude in northern Piedmont is at 900 m whereas the southern slopes go down to 0 m in the Chott Melrhir basin. The geographical opposition and steepness of the two sides of the massif explain the large diversity of bioclimates, ranging from upper subhumid (cedar forest of Djebel Chelia) to saharian (southern Piedmont).

A two years stay (1984-86) at Khenchela allowed one of us (L.C.) to sample *Ophisops* (Lacertidae) populations over the whole Aures massif. Field sampling revealed a population heterogeneity. However, the only species mentioned in Algeria is *O. occidentalis* Boulenger, 1887 (Boulenger 1891; Olivier, 1894) distributed over the Hauts-Plateaux from Eastern Morocco (Bons, 1960) to Tunisia and Tripolitania in the southwest of Misurata (=Misratha), Western Libya (Boulenger, 1914).
Two other species of *Ophisops* are known in Africa: *O. elegans* Ménétrière, 1832, with a very large distribution area widely spread over Asia Minor (Transcaucasia, Syria, Palestine) reaching eastwards to Kalabagh (Pendjab) and westwards, on the northern side of the Mediterranean, to European Turkey, Kypros, Samos and the Sporades islands (Boulenger, 1921). Marx (1956; 1968) also reports the nominate subspecies in Egypt and Lantz (1930) at Dernah, in Cyrenaica (Eastern Libya), the most western known station. *O. elegans* and *O. occidentalis* distribution areas are widely separated by the Syrte Gulf where the saharian bioclimate reaches the coast. *O. elbaensis* Schmidt and Marx, 1957, described from a single holotype in 1954 from mount Elba, in Southeastern Egypt. That species, 3000 km away from the Aures region, is characterized by its large nuchal scales and by a lack of contact between the parietal scales. It is of no concern to the *Ophisops* studied in the present work.
The topic of this paper is to confirm the populational heterogeneity of *Ophisops* in the Aures massif and to give a possible biogeographical explanation of the current situation.

**Material and methods**

This study concerns 147 individuals sampled over the whole Aures massif. The meristic characters considered were those often used for taxonomic purpose, namely by Boulenger (1921): the number of supraciliary granules, existence of a contact between supraciliary and supraocular scales, number of femoral pores and number of scale rows around the midbody. These data have been submitted to a multivariate analysis.

**Results**

*Existence of two species*

A factorial analysis of correspondences for a matrix composed of the 147 samples and 21 classes of variables for the four selected meristic characters (9 classes for the total number (right + left) of supraciliary granules, two for the contact between supraciliary and supraocular scales, five for the total number (right + left) of femoral pores and five for the number of scale rows around the midbody) was carried out.

This analysis provides a clear separation in the projections of the 147 samples on the first factorial plane. Two morphs, A and B, are differentiated by the following characteristics (table 1):

<table>
<thead>
<tr>
<th>Character</th>
<th>Morph</th>
<th>Range</th>
<th>Mean</th>
<th>S.D.</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraciliary granules</td>
<td>A</td>
<td>0-16</td>
<td>8.24</td>
<td>3.37</td>
<td>very</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>17-27</td>
<td>20.80</td>
<td>2.94</td>
<td>significant</td>
</tr>
<tr>
<td>Femoral pores</td>
<td>A</td>
<td>12-19</td>
<td>14.62</td>
<td>1.23</td>
<td>very</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>16-22</td>
<td>19.57</td>
<td>1.70</td>
<td>significant</td>
</tr>
<tr>
<td>Number of midbody scale rows</td>
<td>A</td>
<td>20-32</td>
<td>26.54</td>
<td>1.49</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>24-28</td>
<td>26.00</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Ratio tail: body length</td>
<td>A</td>
<td>1.19-2.29</td>
<td>1.80</td>
<td>0.24</td>
<td>significant</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1.75-2.55</td>
<td>2.06</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

(i) 100% of A individuals have 16 or fewer supraciliary granules whereas 100% of B have 17 or more;

(ii) 98% of A have 17 or fewer femoral pores whereas 91.5% of B have 18 or more;

(iii) Supraciliary and supraocular scales in A are always in contact and the contact length always exceeds 1/4 of the total length of the supraocular rim. This contact is missing in 83% of B and, when present (17%), it never reaches 1/6 of the total length of
the supraocular rim. There is no significant difference, on the other hand, in the number of midbody scale rows.

The tail-body length ratio was not used in the multivariate analysis since only 107 (73%) individuals have an unbroken tail. This ratio clearly distinguishes A and B morphs (see table 1). Although more difficult to quantify, some other morphological characteristics may be a help in distinguishing A and B morphs in the field:

(i) color pattern. In *Ophisops* this is of alternate dark and clear longitudinal stripes (Blanc, 1978). These stripes are far more conspicuous in the B morph individuals and may be followed to the base of the tail, whereas in the majority of the A morph, these stripes break up in the adult stage (especially the dark and clear latero-ventral ones) and are no longer apparent beyond the armpit.

(ii) head shape. The head profile in the A morph is shorter and more angular above the eyes (fig. 2).

**Distribution areas of the two morphs**

*Ophisops* of the B morph have been sampled at 27 field sites on the southern slopes of the Aures massif, mainly in the two large inner valleys of the Abdi and el Abiod oueds, between 436 m and 1850 m in altitude. These sites extend from lower arid to lower subhumid bioclimates.

Individuals of the A morph are frequent all over the northern slopes of the range (63 sites) from the Piedmont (8-900 m) to 1500 m in altitude, in the upper arid, lower semi-arid and upper semi-arid bioclimates (a single individual has been collected in the lower subhumid bioclimate, in the cedar forest). Their distribution area spreads widely over the southern slopes of the massif in the two large lateral valleys of el Hai and el Arab oueds and their tributaries. In these two outer valleys, the B morph is restricted to the lower part, in the lower arid bioclimate, where the A morph seem unable to live.

**Discussion**

**Taxonomic status.** Having checked our results with the keys of Boulenger (1918, 1921) and Lantz (1930), morph A is attributed to *Ophisops occidentalis* and morph B to *O. elegans*. Five subspecies of *O. elegans* were coined by Boulenger (1918), based on sometimes unreliable criteria (as the author himself noted). Four of these subspecies were refuted by Lantz (1930). The exception was *O. e. schlueteri*, for which no specimen was available to him. The taxonomic subdivisions enable us to outline the large morphological variability of this species and to demonstrate an East-West gradient in the reduction of midbody scale rows, ranging from 38-49 rows in the Pendjab (*O. e. schlueteri*) to 28-34 rows in Syria and Sporades islands (*O. e. ehrenbergi*). With 24-28 rows, the *O. elegans* population in the Aures massif further emphasizes this trend. It is therefore situated at an extreme position in both the scale range and geographical distribution of the species.
**Distribution factors.** The two species of *Ophisops* in the Aures massif have a parapatric distribution, except at one station in the North-East, where one individual of *O. elegans* has been sampled together with several *O. occidentalis*. No hybrids have been observed in the contact zone.

In parapatric distribution, *O. elegans* dwell in drier and more open biotops (steppes) whereas *O. occidentalis* are more abundant in dense pine forest. Hence, in the lower subhumid region, *O. elegans* is restricted to the driest vegetation, the *Juniperus thurifera* steppe; however, in the lower arid region where *O. occidentalis* does not occur, *O. elegans* is found in the wettest biotops (the banks of oueds).

Evidently interspecific exclusion is not based on physiological criteria since *O. occidentalis* occurs in the outer valleys, at the same bioclimatical stages as those of *O. elegans* in the inner valleys (see fig. 1).

Current distribution may be explained by a competitive exclusion favouring *O. occidentalis* which has wiped out *O. elegans* from the large, deep outer valleys. As a matter of fact, in the hydrographic system of Oued el Arab, *O. occidentalis* is abundant in the pinewood forest of the Beni Imloul, whereas *O. elegans* is restricted to high altitude, dry and windswept short grasslands at the foot of the summittal cliffs. In the West, *O. occidentalis* has invaded the largest part of the Oued el Haï valley to the limits of the lower arid region and, crossing the fairly flat watershed, has invaded the upper valley of the Oued...
Bouzina, a western tributary of Oued Abdi. It appears to have been checked in its spread towards Oued Abdi by a high anticlinal relief giving a dry and sheer cliff edged cluse at the confluence of the oueds Bouzina and Abdi. The western line separating the two species runs along the escarpment: *O. occidentalis* dwells on the Piedmont whereas *O. elegans* is restricted to the high altitude, dry and windy short grasslands. However, in the whole Oued el Abiod valley, *O. elegans* is the only occurring *Ophisops* species.

**Zoogeographical interpretation.** Many investigations in the Sahara desert and surrounding countries (reviews in Alimen, 1987; Lézine et al, 1990; Petit-Maire et al, 1991) showed that, despite their origin, the quaternary climatic variations in temperature and rainfall have resulted in very large modifications in the geographic limits of the bioclimatical regions. Humid periods have allowed a westward spread of the *Ophisops elegans* distribution from the West of Syrte Gulf, through Tunisia to at least the southern slopes of the Aures massif. During these periods, high altitude areas were too cold and acted as a natural barrier restricting the distribution area of *O. occidentalis* to the Hauts-Plateaux, between the Tellien and Saharian Atlases.

The recent warming, in the last 8-9000 years, would have broken the distribution area of *O. elegans* along the Syrte Gulf and thus isolated the Algero-Tunesian populations; it would have also allowed *O. occidentalis* to cross the Batna and Khenchela sills southwards on either sides of the Aures massif and further spread into the Oued el Haï valley and Oued el Arab valley (as well as its tributary Oued Mellagou) to the West and East respectively, thus eliminating *O. elegans* populations. In the Algerian Nementcha mountain and Tunisian range, *O. occidentalis* have similarly crossed the mountainous zone southwards and established themselves on the southern slopes. In this area, and perhaps westwards along the Saharian Atlas, *O. elegans* could possibly survive as very small, scattered, residual populations.

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**References**


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